

Application No. 10/676,267
Amendment under 37 CFR 1.111
Reply to Office Action dated November 3, 2004
February 3, 2005

REMARKS

By this amendment, the specification has been editorially amended, claims 1-4 have been cancelled and new claim 5-14 have been added to the application. Currently, claims 5-14 are pending in the application.

The disclosure was objected to because the Examiner stated that the label "Figure 1" through "Figure 5" and "Figure 7" through "Figure 8" were not prefaced before describing the figures in the detail description of the preferred embodiments. By this amendment, the specification has been amended to include the label of the Figure numbers 1-5 and 7 as a preface for describing these Figures. It is respectfully submitted that Figure 8 is prefaced in the specification by reciting "FIG. 8 shows the nitride semiconductor element shown in FIG. 7 being mounted face down" on page 38, lines 7-8. Since this description is provided for Figure 8, applicant respectfully submits that it is not necessary to include Figure 8 in another location in the specification. If the amendments made to the specification are not exactly what the Examiner wanted to overcome this objection, the Examiner is respectfully requested to suggest the amendments necessary to overcome this objection to the disclosure.

Application No. 10/676,267
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Claim 1 was rejected under 35 USC 102(e) as being anticipated by Okazaki (U.S. Patent Application Publication No. 2003/0209717 A1). The Examiner believed that Okazaki taught a nitride semiconductor device comprising: at least a p-type nitride semiconductor layer 15; an electrode 16 including at least rhodium and iridium (Figure 1, pages 4-5, paragraphs [0049] and [0061])

Claim 2 was rejected under 35 USC 103(a) as being obvious over Okazaki as applied to claim 1 above, and further in view of Ikeda et al. (U.S. Patent No. 6,475,321 B1). The Examiner believed that Ikeda et al. taught the capability of forming an electrode 102 having an at least two-layer structure including at least iridium and rhodium and laminates of them (Figure 4G, column 5, lines 32-39).

Claim 3 was rejected under 35 USC 103(a) as being obvious over Okazaki and Ikeda et al. as applied to claims 1-2 above, and further in view of Sano (U.S. Patent Application Publication No. 2003/0038294 A1).

Claim 4 was rejected under 35 USC 103(a) as being obvious over Okazaki as applied to claim 1 above, and further in view of Chen et al. (U.S. Patent Application Publication No. 2003/0162342 A1).

Application No. 10/676,267
Amendment under 37 CFR 1.111
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February 3, 2005

These rejections are respectfully traversed in view of the amendments to the claims and the remarks below.

The present invention relates to a nitride semiconductor device having a p-type nitride semiconductor layer and a p-electrode layer. The p-electrode layer has a two layer structure comprising rhodium and iridium and the rhodium is disposed in contact with the p-type nitride semiconductor layer and the iridium is disposed in contact with the rhodium.

In the prior art, it is known to use a p-electrode comprising Ni and Au stacked in this order on the p-type nitride semiconductor layer. However, this structure has a problem in that the Au absorbs light of 550 nm or less so that there is a decrease in luminous efficiency in this device.

Alternatively, if only rhodium (Rh) is used as an electrode on the nitride semiconductor layer, then the contact resistance increases.

In addition, in either an n-type nitride semiconductor layer or a p-type nitride semiconductor layer, if iridium (Ir) and rhodium (Rh) are stacked in this order on the nitride semiconductor layer, such an electrode cannot establish the ohmic contact even after annealing.

Application No. 10/676,267
Amendment under 37 CFR 1.111
Reply to Office Action dated November 3, 2004
February 3, 2005

Further, in an n-type nitride semiconductor layer, the ohmic contact cannot be obtained even forming the electrode of Rh and Ir in this order on an n-type nitride semiconductor layer.

In the present invention, the inventor has found that the specific order of a p-type nitride semiconductor layer in contact with Rh which in turn is in contact with Ir (these two layers forming the p-electrode) forms a nitride semiconductor device having excellent ohmic features.

This arrangement is now specifically claimed and it is not shown or suggested in any of the prior art references.

Specifically, claims 1-4 have been cancelled and new claims 5-14 have been added to the application. New independent claim 5 recites a nitride semiconductor device including "a p-type nitride semiconductor layer; and a p-electrode having an at least two-layer structure; wherein said p-electrode includes a rhodium layer disposed on said p-type nitride semiconductor layer and an iridium layer disposed on the rhodium layer". No prior art references show these features.

Okazaki (U.S. Patent Application Publication No. 2003/0209717 A1) discloses a semiconductor light-emitting element. According to paragraph 0049, the p-side electrode materials are described as including Ni, Pt, Au, Pd, Co, V, Ir,

Application No. 10/676,267
Amendment under 37 CFR 1.111
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February 3, 2005

Rh and other chemical elements. While Ir and Rh are discussed as potential electrode materials, there is no discussion in Okazaki describing that the p-electrode includes a rhodium layer disposed on the p-type nitride semiconductor layer and an iridium layer disposed on the rhodium layer as recited in claim 5. Therefore, Okazaki does not show the features of claims 5-14.

Ikeda et al. (U.S. Patent No. 6,475,321) do not make up for the deficiencies in Okazaki. Ikeda et al. relate to an electrode substrate and a recording medium that can be used in computer related devices and audio-visual devices such as video discs. Ikeda et al. does not relate to a nitride semiconductor device. Further, Ikeda et al. disclose in column 5, lines 34-37, that the metal electrode layer 102 can include noble metals such as Pt, Pd, Ir, Rh, Ru and Au and alloys of any of them as well as laminates of such materials. Even though Ikeda et al. disclose that a metal electrode layer can be made of Rh and Ir and well as laminates, there is no teaching in Ikeda et al. for using a particular order of these materials. Further, applicant respectfully submits that one of ordinary skill in the art would not have combined the teaching of making a metal electrode of Rh and Ir used in a recording medium as taught by Ikeda et al. into the nitride semiconductor device adjacent to the p-type nitride

Application No. 10/676,267
Amendment under 37 CFR 1.111
Reply to Office Action dated November 3, 2004
February 3, 2005

semiconductor layer of Okazaki to render the features of claim 5 obvious.

Sano (U.S. Patent Application Publication No. 2003/0038294 A1) discloses a nitride semiconductor laser. Sano only discloses using RhO as an adhesive layer. RhO is a completely different material than Rh. Sano does not mention making an electrode of Rh. Further, Sano does not mention making an electrode of Rh and Ir and being in a particular order in the device. Therefore, it is respectfully submitted that one of ordinary skill in the art would not have combined the teaching of using RhO as an adhesive layer as taught by Sano into the nitride semiconductor device adjacent to the p-type nitride semiconductor layer of Okazaki to render the features of claim 5 obvious.

Chen et al. (U.S. Patent Application Publication No. 2003/0162342 A1) disclose making metal gates in deep sub-micron CMOS devices. Chen et al. does not mention making an electrode of Rh. Further, Chen et al. does not mention making an electrode of Rh and Ir and being in a particular order in the device as claimed in claim 5. Therefore, it is respectfully submitted that one of ordinary skill in the art would not have combined any of the teachings of Chen et al. into the nitride semiconductor device adjacent to the p-type nitride semiconductor layer of

Application No. 10/676,267
Amendment under 37 CFR 1.111
Reply to Office Action dated November 3, 2004
February 3, 2005

Okazaki to render the features of claim 5 obvious. Also, applicant respectfully submits such a combination is not possible because a CMOS device is completely different than a nitride semiconductor device and one of ordinary skill in the art would not seek to combine elements from such diverse subject areas without a clear teaching in either reference, which is clearly lacking.

In view of foregoing claim amendments and remarks, it is respectfully submitted that the application is now in condition for allowance and an action to this effect is respectfully requested.

If there are any questions or concerns regarding this amendment or the remarks, the Examiner is requested to telephone the undersigned at the telephone number listed below.

Respectfully submitted,



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